BIOREMEDIATION OF MTBE UTILIZING PERMEABLE REACTIVE BARRIER TECHNOLOGY

3-Year ESTCP Demonstration at Port Hueneme, CA

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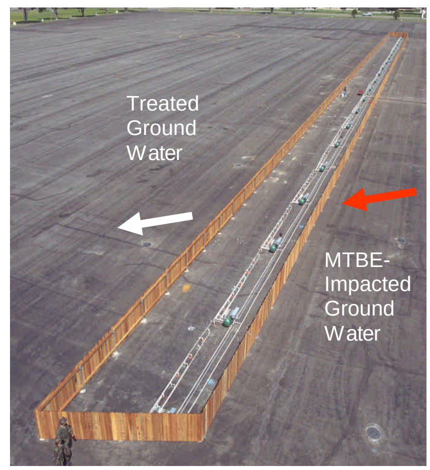
Background

This nationally recognized and award-winning technology is the product of five years of collaboration between industry, academia, and the U.S. Department of Defense (DoD). It represents the first proven low-cost solution for what is now becoming to be recognized as a nation-wide threat to our water resources. At one site alone, application of this new technology has led to documented cost-savings of over $30 million.



There are hundreds of thousands of constructed underground storage tank systems in the United States; most of these are associated with petroleum fuel storage and dispensing at service stations and convenience stores. Historical data suggests that, even with state-of-the-art site construction techniques, materials, and leak detection systems, most of these systems will leak at some time, and that many of these leaks will go undetected. When undetected and unabated, these releases can adversely impact ground water resources. In some cases, private residential wells become contaminated, and in other cases municipal well fields may be rendered unusable.

With the advent of federally mandated cleaner burning fuels containing MTBE (methyl-tert butyl ether), this problem has grown. Because MTBE is more recalcitrant and soluble than other fuel components, and because maximum allowable MTBE concentrations in beneficial use aquifers are as low as 5 parts per billion, potential adverse impacts to water resources are much greater than in the past. USGS studies have shown nationwide impacts to ground water resources and private drinking water wells. For example, the municipal well fields for the City of Santa Monica and City of South Lake Tahoe are currently unusable as a result of MTBE contamination.

Prevention of impacts and the treatment of MTBE-impacted ground water is problematic as MTBE is resistant to treatment by traditional technologies. This technology is applicable both for pollution prevention (as part of the initial construction at an underground storage tank site to treat accidental releases) and for restoration (at sites impacted by past releases). Relative to conventional technologies, this innovative technology is more cost-effective, has minimal maintenance and energy requirements and eliminates the waste streams typically associated with conventional technologies.

Methods

The in-situ "biobarrier" is a passive flow-through treatment system that utilizes natural processes to treat ground water impacted by fuel components, including MTBE. Ground water, under natural-gradient conditions (i.e. no pumping) carries contaminants, such as MTBE, to the engineered in-situ treatment zone. The target contaminants are then aerobically degraded within the treatment zone, and ground water leaving the treatment zone is free of those contaminants. The system can be designed and installed as part of a new construction for pollution prevention of impacts from inevitable leaks, or for treatment of existing ground water contamination.

System components include a compressor or oxygen generator, gas injection wells, ground water monitoring wells and a control system composed of timers and solenoid valves. For demonstration purposes, these components were placed aboveground at the demonstration site; however, at most sites, many of these components can be installed in underground vaults and utility corridors, or in small storage sheds.

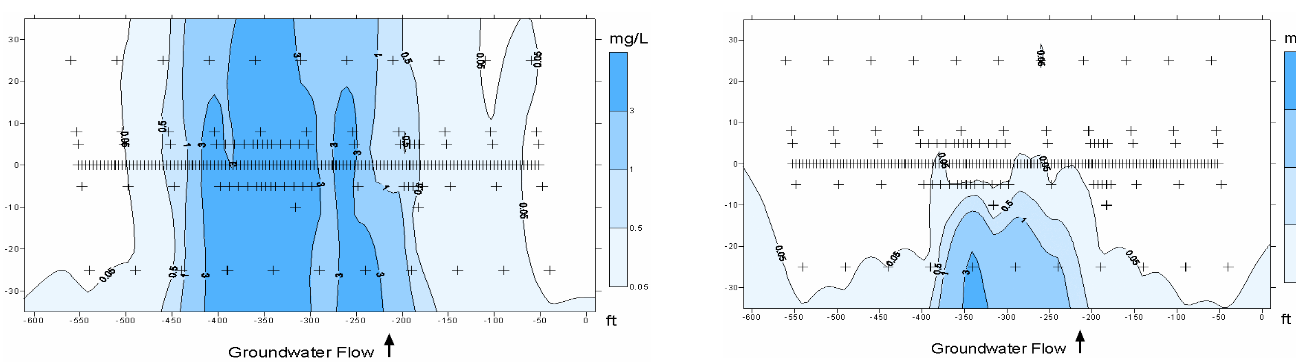
Oxygen gas or air is injected into the aquifer to increase dissolved oxygen levels and to create a zone conducive to aerobic biodegradation. The gas injection is periodic (not continuous) and gas trapped in the aquifer pores continues to provide oxygen between gas injection cycles. At some sites the oxygen addition may result in a sufficient increase in the activity of indigenous MTBE degraders (biostimulation), while the addition of a special MTBE-degrading culture (bioaugmentation) may be necessary at other sites to achieve the desired level of treatment. In the bioaugmented sections, the aquifer was inoculated with either the Shell Global Solutions MC-100 or the SC-100 MTBE-degrading cultures. This was accomplished by direct injection at the desired depths through open-ended rods in December 2000. Culture was delivered to the 9 – 20 ft BGS interval, and two 70-ft long (approximately) sections were inoculated.

Results

The full-scale demonstration system has achieved a treatment efficiency of >99.9% for all target contaminants (MTBE, TBA and BTEX). Samples collected from most of the down-gradient monitoring wells now contain <5 ug/L MTBE and non-detectable levels of BTEX components, meeting California's stringent regulatory requirements for beneficial use aquifers.

Permitting issues related to this technology involve those normally associated with well drilling/ waste disposal. Air and oxygen injection normally does not require a permit. For bioaugmentation projects, microbe injection should be discussed with regulators during the design phase. For the Port Hueneme MTBE plume, the Los Angeles Regional Water Quality Control Board accepted the application of the biobarrier technology as the final remedy for the plume.

MTBE Concentration Contours Before (left) and After (right) Showing Biobarrier Effectiveness



References

The final reports for the ESTCP MTBE biobarrier demonstration will be available on ESTCP's web site **www.estcp.org** in late spring 2003.